All input sections are now more easily accessed by the user through drop-down menus. However, if the user wishes to access the input area as was available in BCM2, this option continues to exist.

Finally, the BCPM provides methods to process multiple investment and expense views across multiple states. This provides the user with a great deal of flexibility in performing multiple scenario analysis.

Model Methods

CBG Input Data

The CBG input data[2] for the BCPM was developed by Stopwatch Maps. An overview of the input data development is contained in Attachment A.

Assumptions for Loop Technology

Feeder cable (cable placed so that it can be supplemented at a later date) is deployed as analog copper plant where the total loop distance is less than the user-specified maximum copper cable length.[3] If the loop distance exceeds the maximum loop distance value, fiber feeder plant is deployed. Fiber feeder may extend into the CBG to maintain the maximum copper distribution cable distance set by the model user. The purpose of the maximum copper distribution constraint is to maintain the standard transmission and signaling characteristic of the loop network.

Distribution plant may contain analog copper technology when terminating signals at a voice grade level, or may utilize digital carrier when terminations are made at the DS1 signal level for a percentage of business lines.

BCPM uses two types of digital loop carrier (DLC) equipment depending on the number of lines needed at each remote terminal location. For line capacities greater than 240 lines, investments associated with large DLC systems are used. For capacities of 240 lines or less, investments associated with small DLC systems are used. The large DLC having a total capacity of 2,016 voice grade channels per four fibers and the small DLC having a total capacity of 672 voice grade channels per four fibers.

Assumptions for Feeder Plant Architecture

Feeder plant uses a tree and branch topology, with plant routes intersecting at right angles. Each feeder cable begins at the central office and ends at the feeder/distribution interface (FDI). Fiber feeder may extend into the CBG to ensure that the user specified maximum copper cable length is not exceeded, thus dividing the CBG into multiple distribution areas.

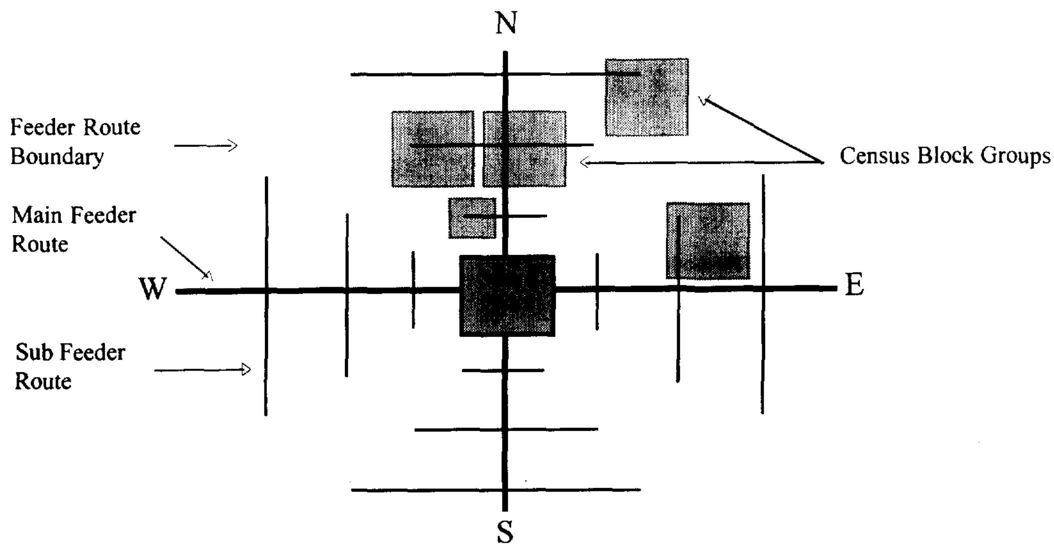
Four main feeder routes leave each central office[4]: directly East (quadrant 1); North (quadrant 2); West (quadrant 3) and South (quadrant 4). The feeder route boundaries are at 45 degree angles to the main feeder routes.

[2] The data included in the BCPM is the property of Stopwatch Maps Inc.. It is provided exclusively for use in the BCPM. All other uses are prohibited except by explicit agreement with Stopwatch Maps, Inc..

[3] The user may specify maximum copper distances of 9,000 feet, 12,000 feet, 15,000 feet, or 18,000 feet.

[4] A central office may have less than four feeder routes if no CBGs are located within a feeder quadrant.

Feeder Plant Architecture



Both copper and fiber feeder cables share the structure and placement costs in the main feeder systems. As the main feeder routes move away from the central office and deploy cable capacity to the CBGs, the feeder cables taper in size to the capacity necessary for each individual segment.

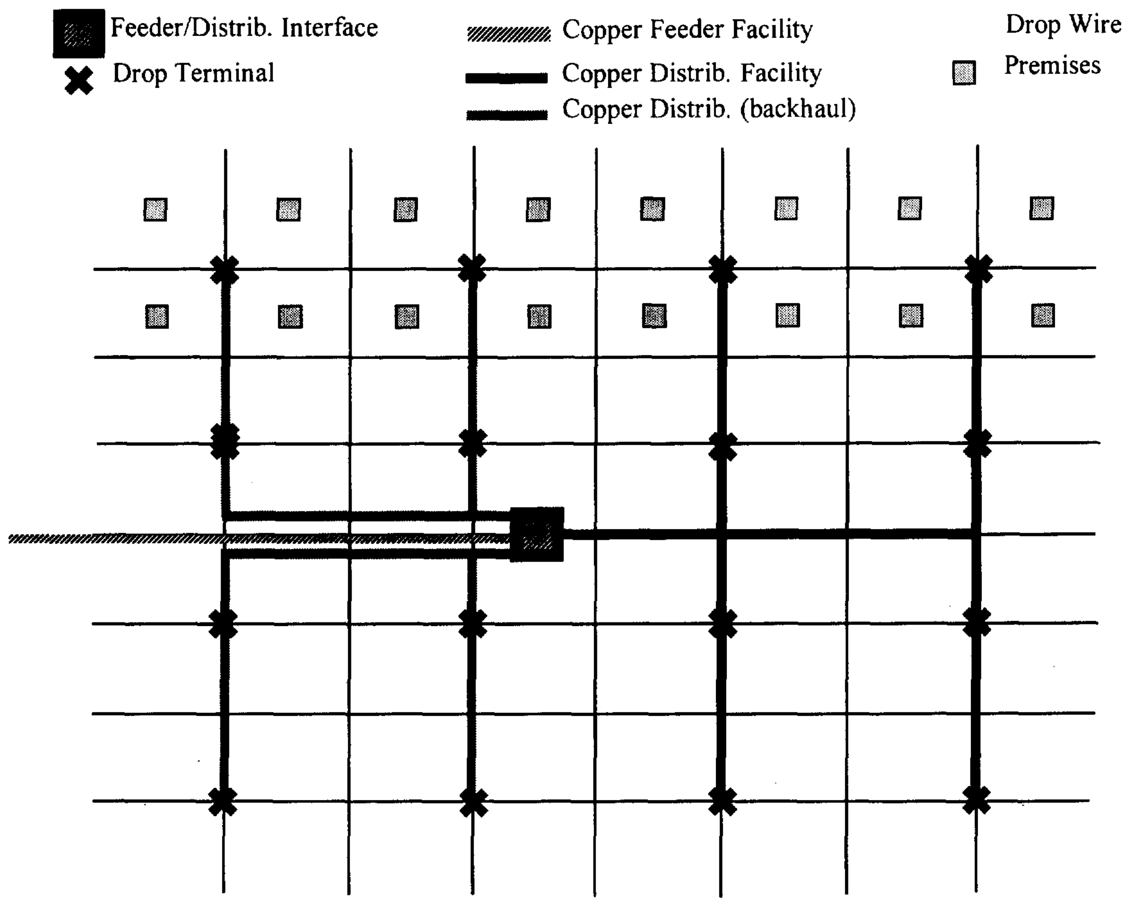
Copper feeder cables range in size from 25 pair cable to 4,200 pair cable, while fiber feeder cable sizes range from 12 strand cable up to 288 strand cable. Feeder plant costs include: material cost of cable and electronics; capitalized cost of structure and placing the cable including manholes, conduit, and poles; electronics costs at the central office and remote; costs of in-line terminals, FDIs, splicing; and engineering.

<u>Assumptions for Distribution Plant Architecture</u>

As with the BCM2, the BCPM assumes that all households within a CBG are uniformly distributed. In rural areas, the CBG area input data has been reduced reflecting the removal of areas that do not have road access.

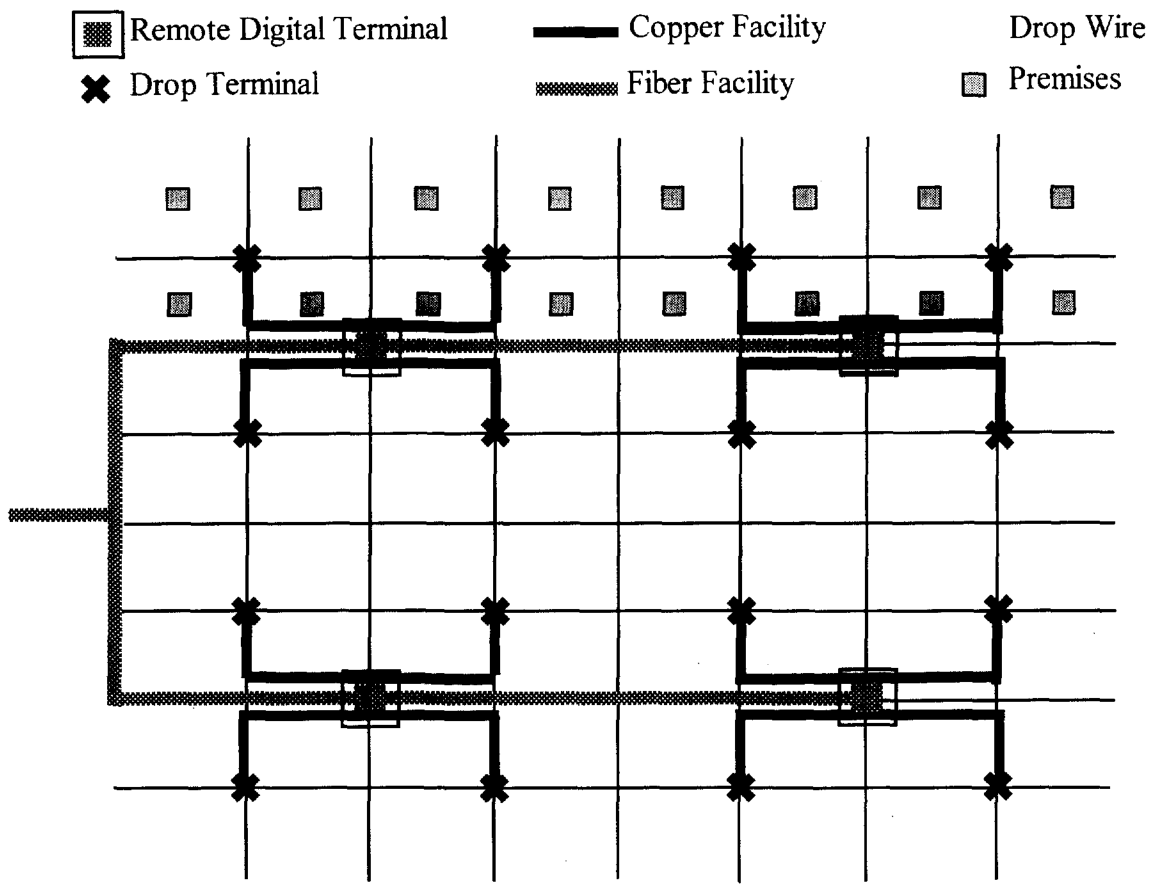
Distribution cable begins at the distribution side of the FDI and continues to the customer premise. The distribution plant is designed to reach all households in the CBG through the placing of cables between subdivision lot lines. BCPM more precisely designs distribution plant for each CBG to ensure cables pass by each premise. The number of distribution cables may be as few as one for a small CBG to 20 or more cables in more densely populated CBGs. An example of distribution plant with a copper feeder system is displayed below.

Example of Distribution Plant With Copper



In larger rural CBGs that are very sparsely populated, it may be necessary to extend the fiber feeder into the CBG itself to maintain copper cable lengths less than the user-specified maximum. An example of fiber feeder extending into the CBG is displayed in the next figure.

Example of Distribution Plant With Fiber



Investments for distribution plant include the material cost of the cable and its cost of installation and structure, as well as the network interface device, the drop wire, the drop terminal, splicing and engineering. Distribution cable sizes range from 25 pair cable to 3600 pair cable.

Since business lines are included by CBG, the BCPM distribution architecture uses fiber cable in very dense CBGs that require larger cable capacity than a maximum size copper distribution cable. Additionally, BCPM terminates a percentage of the lines in these dense CBGs at a digital DS-1 signal level, since a percentage of businesses have digital PBXs that utilize such capacity. (This is a user variable input).

Assumptions for Density

Density of existing development in a geographic area impacts three major aspects of the cost of providing basic telephone service. First, the density of existing development determines the construction methods that are used in deploying telephone plant. Second, the density of development determines the potential for growth and the future need for additional capacity. Finally, the density of development influences the mix of underground, buried, and aerial plant.

CBG densities are calculated in a three step process. First, the business lines are divided by a user input density adjustment. The default value for the density adjustment is 10 business lines occupying the physical space of one household unit. In the second step, the adjusted business lines are summed with the CBG households. Finally, this sum is divided by the square miles of the CBG. This insures that the proper density characteristics are assigned to the CBG.

Based upon the CPM, the BCPM uses seven different density groups to determine plant characteristics. These density classifications more closely match engineering breakpoints and, in addition, are almost equally spread on a logarithmic scale:

Density Groups (Households Plus Business Premises per square mile of CBG)

1.	0	to	10
2.	11	to	50
3.	51	to	150
4.	151	to	500
5.	501	to	2,000
6.	2,001	to	5,000
7.	5,000	and greater	

The density groups determine the mixture of aerial, buried, underground plant, feeder fill factors, distribution fill factors, and the mix of activities in placing plant and the cost per foot to place plant. These are all user adjustable inputs.

Terrain Assumptions

U.S.G.S. and Soil Conservation Service data for four terrain characteristics that impact the structure and placing cost of telephone plant are included as inputs to BCPM by CBG. These terrain variables include depth to water table, depth to bedrock, hardness of bedrock, and the surface soil texture. Combinations of these characteristics determine one of four placement cost levels:

Placement Cost Levels (increasing placement difficulty)

1. (Normal) Neither water table depth nor depth to bedrock is within placement depth for copper or fiber cable *and* surface soil texture does not interfere with plowing.
2. Either soft bedrock is within cable placement depth *or* surface soil texture interferes with plowing.
3. Hard bedrock is within cable placement depth.
4. Water table is within cable placement depth.

When both fiber cable and copper cable are placed together in an underground or buried installation, the fiber placement depth is used to determine the placement difficulty.

Assumptions for Switch Technology

The BCPM exclusively uses digital switching technology. However, no assumptions are made as to what type of switch is deployed (host, remote, or stand alone) or which manufacturer (e.g., Nortel, Lucent) produced the switch. Rather, the BCPM uses a composite cost curve derived from different size, types, and brands of generic digital switches for calculating switch investments. While each size switch has a unique fixed or start-up cost and a unique per line cost, the composite cost curve takes this into account through its derivation. The start-up cost includes central processor frames, billing and data recording equipment and frames, miscellaneous power equipment and back-up power, the main distribution frame, frames for testing, and basic software.

The data used in the model was based upon a Best of Breed data request to the LECs. This study requested that the LECs provide SCIS[5]-type output from model offices. These model offices were designed to only include the basic functionality necessary for the provisioning of basic local service.

Once the data was received, statistical modeling was performed to determine whether Company Size, Host/Remotes, and Company had a significant influence on the shape of the basic switch curve. Host/Remote was not a significant factor and therefore not used in the model. Company Size (Small, Medium, Large) was significant. However, due to the fact that only two midsize companies (the others were large) provided data, the proprietary nature of their data could not be protected[6]. Therefore, the factor was not used. Finally, Company was significant, as expected. This represents the fact that each company negotiates its' discounts, engineers to its' specifications, uses specific brands, etc. However, since all LECs did not provide data, this variable could not be used.

After excluding the aforementioned variables, a final switch curve is derived. The basic function of the switch curve is

Per line Investment = 225 + 261,871/Line size of the switch.

[5] SCIS is a Bellcore owned Switching cost model. This model has been widely accepted throughout the industry and by regulatory bodies as an accurate tool for measuring switching costs.

[6] It is anticipated that enough companies will respond so that a separate switch curve can be developed for each company size. This will allow the recognition that larger LECs may have greater buying power than smaller LECs.

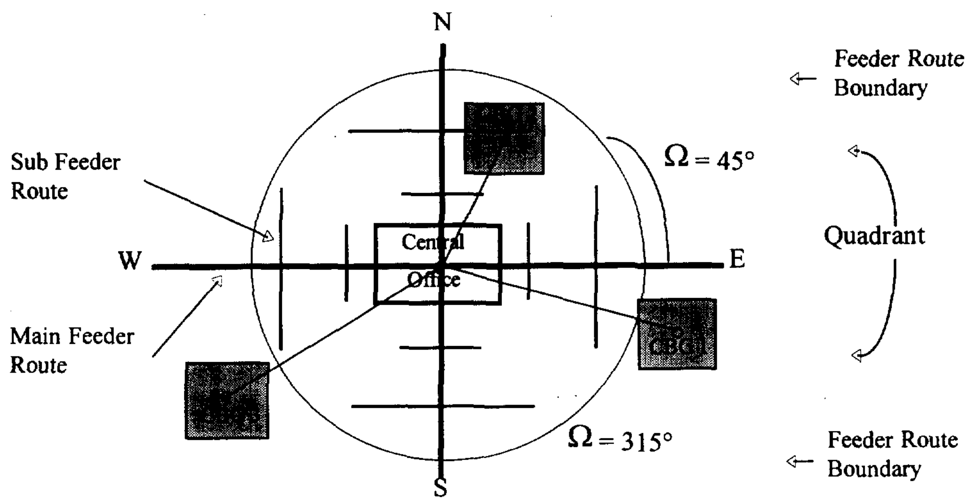
Algorithms to Develop Basic Local Service Costs

Feeder Plant Distance

Typically, each LEC central office has four main feeder routes, radiating out from the central office (BCPM uses East, North, West, and South main feeder routes). Branching off from the main feeders are sub-feeders, typically at right angles to the main feeder, giving rise to the familiar tree and branch topology of feeder routes. Subscribers or homes are somewhat randomly spread within the route serving areas. The routes become less densely populated as the distance from the central office increases.

The geographic centers (centroids) of the CBGs may fall in any of the four feeder route serving areas. In order to determine on which of the four main feeder routes (or quadrants) a CBG is served, an angle Ω is calculated. The angle Ω represents the counter-clockwise rotational angle between a line connecting the CBG with the closest central office and a line headed directly east from the central office. This is displayed in the following figure:

Determination of Feeder Quadrant



The relationship between the angle Ω and the feeder route is found in the table below:

East	Feeder	Route	(Quadrant 1)	0° – 45° ; 315° – 360°	*CBG 1*
North	Feeder	Route	(Quadrant 2)	45° – 135°	*CBG 2*
West	Feeder	Route	(Quadrant 3)	135° – 225°	—
South	Feeder	Route	(Quadrant 4)	225° – 315°	*CBG 3*

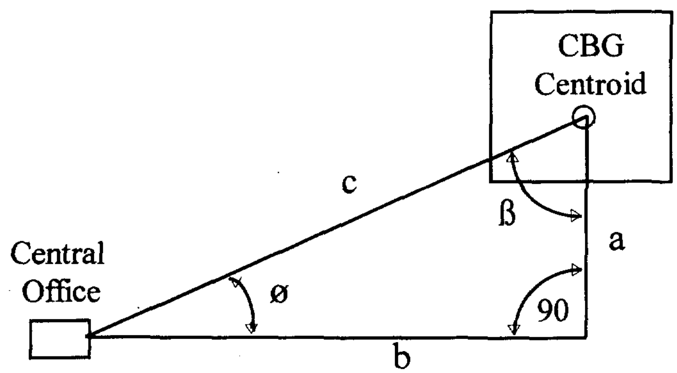
Feeder plant costs for a given CBG are estimated by approximating the length of the feeder cable from the serving central office to the FDI(s) serving the CBG. For simplicity it is assumed that each CBG is square in shape and that households within the CBG are distributed uniformly. In CBGs with less than 20 households per square mile the CBG area is reduced to eliminate non-populated areas.

Feeder plant consists of multiple segments. The first feeder segment leaving the central office travels along one of the four main feeder routes. The next segment of feeder plant (referred to as sub-feeder) leaves the main feeder route at a right angle and proceeds to the CBG. If the CBG is so large that copper distribution distances exceed the user-specified maximum length, as in the above Example of Distribution Plant with Fiber the feeder plant is extended into the CBG. In this example, more than one feeder leg is required within the CBG. In this case, the sub-feeder leg extending horizontally from the main feeder route splits vertically at the edge of the CBG at a right angle. This vertical sub-feeder segment is referred to as Part 1 sub-feeder. From this vertical sub-feeder, emanate two horizontal sub-feeder cables referred to as Part 2 sub-feeders. Each time additional sub-feeder cables are needed, the additional cable is sized to efficiently serve the demand along its portion of the route.

Calculating the feeder distance is a two-step process. First, the feeder plant distance to the CBG is calculated and second the feeder distance within the CBG is calculated.

The calculation of the feeder distance to the CBG starts with the airline distance between the serving central office and the centroid of the CBG. This is determined using the latitude and longitude of the serving central office and the latitude and longitude of the centroid of the CBG. Next, the airline distance is mathematically converted to an equivalent feeder plant route length.

Feeder Distance Calculation



Airline distance between Central Office and CBG Centroid = line c

Angle between Main Feeder Route (line b) and line c = Ø (determined from long./lat.)

Main Feeder Route Distance to CBG = line b = c * cos Ø

Sub-feeder route distance (line a) is calculated in a similar manner, however the sub-feeder does not extend into the CBG.

In cases where feeder plant is deployed within the CBG due to the considerations mentioned above, the Part 1 sub-feeder distance (d_{Part1}) is calculated as follows:

N_{LEG} = Number of Feeder-Type Legs
W_{CBG} = Width of CBG in feet

$$d_{Part1} = \left(\frac{N_{LEG}-1}{N_{LEG}}\right) * W_{CBG}$$

The Part 2 sub-feeder distance (d_{Part2}) is calculated as follows:

d_H = Longest Actual Horizontal Copper Distribution Distance
L_{LOT} = Length of Base Lot Side in feet

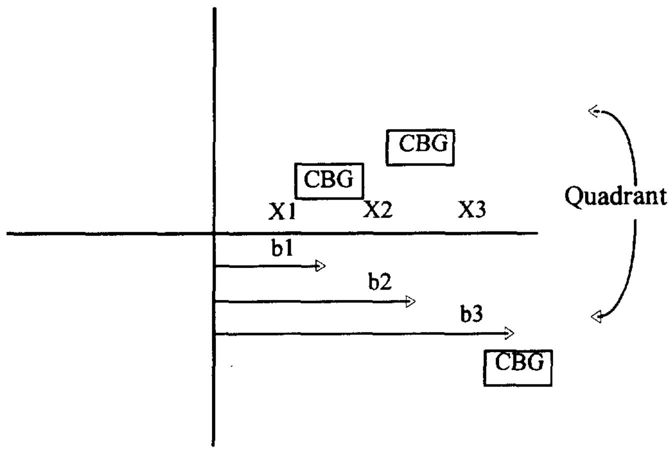
$$d_{Part2} = W_{CBG} - L_{LOT} - d_H$$

The preceding distance calculations may be increased if the minimum or maximum slope measurements for a CBG reach the trigger values. If the slope is greater than the trigger value, then the feeder and sub-feeder distance are increased by a user specified factor.

Shared Feeder Plant Distance

CBGs that are served along a common feeder route share feeder facilities. BCPM calculates the distances for the shared feeder segments by calculating the line b distance described above for each CBG in a quadrant. Once the line b distances are calculated, the model sorts the CBG data first by central office, then by quadrant, and finally by line b distance. An example of three CBGs in main feeder quadrant 1 is shown below.

Shared Feeder Distance Calculation



In this example, there are three main feeder segments in quadrant 1: X1, X2, X3. The formula for calculating an individual feeder segment distance is:

For n (the number of CBGs within a quadrant) > 1,

Main feeder segment $X_n = b_n - b_{n-1}$

The total feeder distance for a CBG is the sum of main feeder distance and sub-feeder distances.

Cable Capacity and Material Investments for Shared Feeder Plant

The required capacity of a segment of copper feeder plant is determined by the sum of the lines of all CBGs utilizing that particular segment and copper technology. Next, the sum of these lines is divided by the fill factor for the density group associated with the segment. This calculation yields the copper cable capacity required for the segment. BCPM then "looks up" the cable capacity in a table to determine the actual cable size available (and its associated cost per foot) to meet the segment capacity. If the required capacity is greater than the size of the largest available cable, BCPM determines the number of maximum size cables and the next size cable to meet the capacity needs of the segment. The copper feeder cable sizes available in the model are 25, 50, 100, 200, 400, 600, 900, 1200, 1800, 2400, 3000, 3600, and 4200 pair.

The required capacity for a segment of fiber feeder plant is determined in a similar manner, however, large DLC technology and small DLC technology cannot share fiber strands because of differing transmission parameters. For large DLC systems, four fibers can carry up to 2,016 voice grade paths. If the segment capacity exceeds this limit, four additional fibers are required for each increment of 2,016 voice grade paths. For small DLC systems, four fibers can carry up to 672 voice grade paths. Like large DLC, each additional increment of 672 voice grade paths capacity requires an additional four fibers. The voice grade paths are determined by technology by summing the lines by CBG utilizing the particular technology and dividing the sum by the fill factor associated with the density group of the feeder segment.

The total capacity for a fiber feeder segment is the sum of the required large DLC fiber strands and required small DLC fiber strands. BCPM determines the number of maximum size fiber cables and the size of the additional fiber cable to meet the capacity needs of the segment. The fiber feeder cable sizes available in the model are 12, 18, 24, 36, 48, 60, 72, 96, 144, and 288 strands.

Once each feeder segment's cable size in feet and cost per foot is determined, a total material cost is calculated for the segment. Each CBG that utilizes the segment facilities shares the material cost on an equal cost per unit (per line).

Distribution Plant Distances

The CBG plant design is dependent upon the square mileage and the number of households served within the CBG.

The CBG is first checked to determine if the width of the CBG is greater than twice the maximum copper serving distance (specified by the user). If the width is greater, then the appropriate number of feeder-type legs will be extended into the CBG to sub-divide the area into multiple distribution areas. The vertical and horizontal copper distribution distances (d_V, d_H) from each FDI location are calculated as follows:

W_{CBG} = Width of CBG in feet
L_{LOT} = Length of Base Lot Side in feet
N_{LEG} = Number of Feeder-Type Legs
d_{HRC} = Number of Lots between Terminal Locations
N_{LOT} = Number of Lots Per Base Side

$$d_V = \frac{W_{CBG}}{N_{LEG}} \quad 2\,(L_{LOT}) \qquad\qquad d_H = C_{MAX} - .5\,(W_{CBG}) - L_{LOT}$$

IF $N_{LOT} = d_{HRC}$, THEN $d_H = .5 * (N_{LOT} - 1)$

OTHERWISE $d_H = (.5 * (d_{HRC}) - 1) * L_{LOT}$

Cable Capacity and Material Investments for Distribution Plant

Copper cable and fiber cable capacities for distribution plant are determined in a similar manner as feeder plant. However, distribution plant only provides capacity to serve lines within the CBG. Thus, for distribution plant each of the horizontal plant legs serves an equal portion of the CBG line capacity as do the vertical legs. As with feeder plant the cable sizes (and their cost per foot) deployed by the model are determined by utilizing a "look up" table of the number of lines served by each cable leg (done separately for horizontal and vertical cables) divided by the fill factor for the CBG's specific density group.). The copper distribution cable sizes available in the model are 12, 25, 50,100, 200, 400, 600, 900, 1200, 1800, 2400, 3000, and 3600 pair.

The total distribution cable material investment is calculated as follows for both copper cable and fiber cable:

Distribution Cable Investment =

Number of Horizontal Distribution Legs * Horizontal Distribution Distance * Horizontal Cable Cost Per Foot + Number of Vertical Distribution Legs * Vertical Distribution Distance * Vertical Cable Cost Per Foot

Structure and Placement Costs

Structure and the cost of placing plant include the costs of poles, conduit, etc., and the capitalized costs of installing cable and wire facilities plant. BCPM uses a cost per foot for structure that varies by plant type, terrain, and density group. It represents the material and placing cost of structure. Each density group and terrain difficulty reflects a different mix of placing activities and structures. The structure calculations are integrated into the BCPM investment module. Following are examples of the inputs for underground, buried and aerial plant structure for the normal level of terrain difficulty associated with the 501 to 2,000 Households per Sq. Mi. density group.

	Underground				
	Normal				
Density Group 501-2000	**Install**	**Feeder**		**Distribution**	
Conduit Installation	Cost per Unit	% Activity	% Assigned Telephone	% Activity	% Assigned Telephone
Trench & Backfill	$ 2.69	27.00%	95.00%	40.00%	80.00%
Rocky Trench	$ 4.83	0.00%	95.00%	0.00%	80.00%
Backhoe Trench	$ 3.38	30.00%	95.00%	7.00%	80.00%
Hand Dig Trench	$ 6.00	6.00%	95.00%	6.00%	80.00%
Boring	$ 13.26	2.00%	95.00%	2.00%	80.00%
Cut & Restore Asphalt	$ 9.45	13.00%	95.00%	13.00%	80.00%
Cut & Restore Concrete	$ 10.30	12.00%	95.00%	12.00%	80.00%
Cut & Restore Sod	$ 4.41	10.00%	95.00%	20.00%	80.00%
		100%		**100%**	

Density Group 501-2000	Buried Normal				
	Install	Feeder		Distribution	
Buried Cable Installation	Cost	% of Activity	% Assigned Telephone	% of Activity	% Assigned Telephone
Plow	$ 1.22	15.00%	100.00%	20.00%	100.00%
Rocky Plow	$ 1.51	0.00%	100.00%	0.00%	100.00%
Trench & Backfill	$ 2.69	26.00%	95.00%	20.00%	80.00%
Rocky Trench	$ 4.83	0.00%	95.00%	0.00%	80.00%
Backhoe Trench	$ 3.38	11.00%	95.00%	2.00%	80.00%
Hand Dig Trench	$ 6.00	6.00%	95.00%	6.00%	80.00%
Bore Cable	$ 13.26	2.00%	95.00%	2.00%	80.00%
Push Pipe & Pull Cable	$ 7.98	5.00%	95.00%	5.00%	80.00%
Cut & Restore Asphalt	$ 9.45	13.00%	95.00%	13.00%	80.00%
Cut & Restore Concrete	$ 10.30	12.00%	95.00%	12.00%	80.00%
Cut & Restore Sod	$ 4.41	10.00%	95.00%	20.00%	80.00%
		100%		**100 %**	

Density Group 501-2000		Aerial Normal			
		Feeder		Distribution	
Aerial Cable Installation	Cost	Installation Cost per Unit	% Assigned Telephone	Installation Cost per Unit	% Assigned Telephone
Poles	$ 368.17	$ 358.58	50.00%	$ 358.58	50.00%
Anchors and Guys	$ 68.00	$ 255.00	100.00%	$ 255.00	100.00%

The first column shows the activity. The second column displays the cost per foot of each activity. The default cost per foot values in the BCPM are based on a national average of available contractor prices for that activity. The third column displays the percent of the activity for the specific density group and terrain difficulty. The sum of the column of percent of activities should be 100 percent. The fourth column represents the percent of the activity assigned to telephone service. In this example, 95 percent of the cost of underground feeder activities are assigned to telephone service, which 80 percent of the cost of underground distribution are assigned to telephone service. In other words, the telephone company shares these activities with other companies 5 percent of the time when placing underground feeder facilities and 20 percent of the time when placing underground distribution facilities. The cost per foot, the percent occurrence of the activity, and the percent of the activity assigned to telephone are multiplied to develop the cost of placing facilities in a density group and terrain situation. The total cost per foot is the sum of the weighted activity costs.

*Structure Cost = Density Group Terrain-Specific Cost Per Foot * Cable Length*

Switch Equipment Investments

Switching investments are calculated based on current central office locations as reported by Ontarget's Exchange Info. The BCPM calculates that total number of switched lines terminated at the central office. In addition, the

BCPM determines the size of the company owning the switch[7]. This value is used to look up the value of the switch curve from the BCPM input table (e.g., fixed costs of $261,871 and variable line amount of $225). Using the line size, the fixed and variable line cost of the switch along with the input table values of switch discount, local telco engineering, power and common, and percent of switch used for local calling, a cost per line for that particular switch can be developed. The function used is as follows:

Cost per line for Local =
[(fixed costs/line size)%local +(variable costs/ switch fill)] * switch discount **
(1 + local telco engineering factor + power and common factor)

Land and Building Investments

Once the switching investment is determined, the land and building loadings are calculated by applying the land ratio and the building ratio. The land ratio is based upon the 1995 ARMIS values of Land divided by the sum of COE (Switching, Operator and Transmission). The Building factor was based upon a LEC Industry data request (the actual data value was a land and building factor, the ARMIS land factor was subtracted to arrive at the building factor). The functions are:

*Land investment = Land Factor * Switch Investment*

*Building investment = Building Factor * Switch Investment*

[7] Even though the BCPM currently has only one cost curve, the BPCM algorithms and input tables have been modified to allow the input of separate switch curves based upon company ownership size (Small, Medium, and Large).

Interoffice Investment

The current version of the BCPM does not have a separate module to develop the interoffice investment. Rather, a factor is applied to switch investment to estimate the interoffice. The BCPM sponsors do not feel that this materially impacts the results of the model. To put it in perspective, Interoffice investment runs at about 3% (based upon the BCM2 value) of the switching investment. If the switch investment were $250 (1000 line switch) and the monthly capital cost for the switch ran at 1.8% (rough estimate), the interoffice monthly cost would be $0.135 ($250 * .018 * .03). Even if this estimate of the Interoffice ratio were off by 50%, the monthly cost would only change by ~$0.07. This is the reason the BCPM sponsors did not feel it was necessary to include Interoffice modeling in this release.

Circuit Equipment Investments

BCPM uses large and small digital loop carrier equipment investments split between the fixed costs of the remote terminal and digital loop carrier costs that vary by line. The fixed remote terminal costs include the optical line interface units, software, cabinet, power, and the access resource manager common card kit, as well as the comparable components at the central office terminal. The per line components include the line cards at the remote terminal and the central office terminal.

The circuit equipment investments by CBG are developed through the use of a "look up" table which provides the appropriate fixed terminal cost for the number of lines using the terminal, as well as the cost per line for the individual terminal size. The investments found in the table include engineering and installation, and represent current price levels that large LECs pay for digital loop carrier systems (including their discount).

Support Investments

Once the model calculates the loop, switching, and interoffice plant (excluding land and building) needed for each CBG, ARMIS developed investment ratios are used to load in the support investments. Support investments represents those plant items not directly used in the provisioning of basic service. They include: Motor Vehicle, Special Purpose Vehicle, Garage Work, Other work Equipment, Furniture, Office Support equipment, and General Purpose Computers. The ARMIS ratios are based upon the 1995 regulated data and are developed as follows:

$$\textit{Account Ratio} = \frac{\textit{(Account Balance)}}{\textit{(Total Plant in Service (TPIS) - Support Investments)}}$$

This ratio is then adjusted by a factor to maintain the relationship of BCMP operating expenses to the booked ARMIS operating expenses.

Annual Cost Factors

The BCPM has been designed to allow inputs of the annual charge factors for all major plant accounts (e.g., conduit has its own values). This was done to recognize that all of the major accounts have differing lives, salvage, cost of removal, tax lives, and survival curves, which ultimately lead to distinct capital costs factors for each account.

The estimates of lives are used as inputs into the BCPM's Capital Cost module to develop the depreciation rates. The lives, salvage, and cost of removal are based upon a LEC industry data survey requesting forward looking values. The curve shapes of the survival patterns are provided by the USTA capital recovery group.

The development of the annual charge factors is as important as the proper building of the plant. The BCPM includes a powerful yet simple model that allows the user to vary the basic inputs to arrive at the Depreciation, Cost of Capital, and Tax Rates for each account. This new module incorporates all of the methodologies that are currently in practice today, including: Deferred taxes, Mid-year, Beginning Year, and End Year placing conventions, Gompertz-Makeham Survival curves, Future Net Salvage, Equal Life Group methods, and many other items. The module also incorporates separate Cost of Debt and Equity rates, along with the Debt to Equity ratio. And as stated, all of these inputs are user controlled.

Once the annual charge factors are developed, they are simply multiplied by the investment (account by account) to arrive at a yearly capital costs. These yearly amounts are then converted to a monthly amount by dividing by 12.

The Annual charge factor categories include:

Rate of Return,
Depreciation,
FIT,
State Taxes, and
Other Taxes

The plant accounts separately accounted for in the model's capital costs are:

Motor Vehicle,
Special Purpose Vehicle,
Garage Work,
Other work Equipment,
Furniture,
Office Support equipment,
General Purpose Computers,
Land,
Building,
Switching,
Circuit/DLC,
Poles,
Aerial Copper,
Aerial Fiber,
Buried Copper,
Buried Fiber,
Underground Copper,
Underground Fiber, and
Conduit

Operating Expenses

To avoid the mischaracterization and misappropriation of costs, the BCPM correctly separates operating expenses from investment in the model. To put the cost of Universal Service in perspective, an average of up to 40-50% of the costs are attributable to the operating expenses of the company.

The BCPM uses investments only to drive the capital costs (depreciation, return, and taxes) of the company. The operating expenses were developed as an expense per line. These per line estimates are not based on ARMIS values. Rather, these expense values were derived by weighting together the LEC estimates of forward-looking expenses per line for each Class A expense account (6xxx series). The expenses were defined as the total forward-looking loop costs for single line residence and business and includes touchtone, a white page listing, and access to operator and emergency services.

In regards to the forward looking nature, the estimates from the various LEC's included such factors as adjustments for productivity gains, exclusion accounts such as Analog switching, and inclusion of forward looking adjustments. However, all estimates started with 1995 actuals (a few companies used multiple years) as the basis of the values. These current year expenses are the best known values of what it costs the LECs to maintain the current efficient telephone network.

This detailed, forward looking, per line design of the BCPM

- Corresponds to the forward looking investments in the model
- Allows the user of the system to determine what is and what is not included in the cost of Universal Service
- Clarifies the understanding of what is driving the cost of Universal Service
- Could allow the use of Benchmark costs
- Avoids mischaracterization of costs
- Avoids the link that causes a discount in investment to discount operating expenses

The correct development of the Universal Service costs cannot utilize an archaic method of using a loaded annual charge factor applied against investment to derive total costs. This method may have worked in the past when the end product was a statewide or company wide cost. However, in developing the cost of Universal Service, one is trying to estimate the costs of smaller geographic units. The use of the loaded annual charge factor method also unfairly penalizes long loop length/high investment customers by assigning more of the operating expenses of the business. However, most costs do not vary by the loop length or loop investment. Rather, they are driven by other cost drivers (e.g., lines, technology, etc..)

In addition to avoiding the inaccuracies associated with using an annual charge factor to load all expenses, the BCPM avoids the additional problems that are the results of deriving an annual charge factor from ARMIS ratios. In effect, by using an ARMIS derived ratio to base the operating expenses on, the model would allocate the current operating expenses of a company based on multiplying forward looking investments by the ARMIS ratio of (current expenses/embedded investments). One cannot be sure what the end product truly represents.

The expense accounts used in the model are:

Network Support
General Support
COE Switching
Operator Systems
COE Transmission
Information Orig/Term
Cable and Wire Facilities
Other Property Plant
Network Operations
Access
Marketing
Services
Executive and Planning
General and Administrative
Uncollectibles

User Adjustable Inputs

Nearly all the variables included in the BCM2 are user adjustable. Pacific Bell, U S WEST, and Sprint have set default values for the inputs at levels that they feel represent forward-looking practices for the deployment of basic local telephone service. Appendix A describes the CBG specific input fields utilized by the BCPM. Appendix B provides a complete listing of user inputs to the investment module.

Development of Default Outside Plant Values

To develop a nation wide average of material, placing, engineering and splicing cost, a questionnaire was sent to participating members of the Best of Breed (BOB) model development team (US West, Bell South, Nynex, GTEC, Bell Atlantic, Ameritech, Sprint, Pacific Bell, South Western Bell, and PTI). The questionnaire requested company forward looking cost for loop material and labor. The material cost provided is based on company specific cost that includes price discounts, therefore, no additional discounts are applied to material cost in the user input tables. The cost information was averaged to develop a national average for default values in the BCPM. Due to some material cost being slightly lower in cost than the next size down (this is due to vendor volume pricing), smoothing was performed to price material cost in a linear arrangement.

Cable Investment:

Average installed cost of copper and fiber cables are developed by company forward looking cost using today's discounted material cost. Copper cables are 26 gauge in the feeder and 24 gauge in the distribution. A 12,000 foot total loop length is set as the default for a breakpoint of copper to fiber technology. This means that copper will be the transport medium from the wire center to the subscriber when the total loop length is 12,000 feet or less. Loop lengths beyond 12,000 feet fiber will be deployed in the feeder along with digital loop carrier. To extend the breakpoint, a user must assume a 26/24 gauge feeder and adjust cable cost accordingly. In addition, cost of load coils and other transmission requirements must be considered when extending copper loop lengths.

The type of underground copper cable used is DucPic to avoid pressurization expense. Buried copper cable is filled armored to minimize cable damage due to water, dig-ups, and animals. Aerial cable is single sheath (BKTA/BKMA) when available, otherwise DucPic cables are used. Messenger installed cost is added to the cost of aerial cable. Buried and aerial fiber cables includes cost for extruded outer duct (cables placed in flexible plastic duct before placement) for additional protection. This method is placing the fiber cable in the duct before placing greatly facilitates the placing operation in aerial and buried plant.

Digital Loop Carrier (DLC) Investments:

The DLC placements in the BCPM uses Integrated Digital Loop Carrier technology. This technology eliminates many of the costs associated with standard or "universal" systems. Fixed cost assumes all first costs associated with the placement of DLC systems at both the remote terminal and the central office. The fixed cost includes common equipment, site preparation, right-of-way cost, remote cabinets, commercial power, protection, central office fiber optic terminal (FOT/COT) etc. The Per Line Cost or variable cost is the cost of line cards on a per line basis (installed cost of line cards divided by 4 services per line card at the Remote Terminal plus the installed cost of the central office line card (DS1 card) divided by 24 services per card. Sizes of DLC systems in the BCPM range from 24 to 2,016 channels. This will provide the flexibility and the economics of deploying sizes based on density and growth.

Structure Costs:

Structure types and costs vary by type of facilities (aerial, buried, or underground), density, and soil conditions. Sizing of conduit and manholes are based on the required amount of facilities required for telephony. No additional capacity has been added for sharing. For example, if a placement of 3 copper cables are required then 3 ducts are placed for the cables and one duct is placed for maintenance. In addition, a pre-cast manhole is placed by the telephone company. Sharing is considered with poles.

Trench cost for both conduit and buried cable is averaged from the forward looking cost data received from the cost questionnaire. Companies also provided data for the cost of different types of trenching done in each of the density zones and for the different types of soil conditions. This information was weighted and averaged for the trenching default cost in the BCPM.

APPENDIX A

Data for BCPM Model

1/29/97

The following summarizes the data to be provided for the BCPM model. This data is provided as a set of comma-separated variable ASCII text files. There are 51 of these files, covering the states and the District of Columbia.

Each comma-separated variable file presents character fields without surrounding quotation marks. Spaces freely appear in such character fields, but commas and ampersands never do. When either a comma or ampersand appears in the original data, it is be converted to a space in that field in the output file.

The former *reference* file, containing one record per Operating Company, is eliminated from the latest data because information from it is joined to every record whose CLLI code matches the LERG data on which it is based.

Each of the 51 state files contains one record per Census Block Group within that state, in the following order, from most major to most minor, all fields in ascending sequence:

Parent Company Name
 Operating Company Name
  Switch CLLI Code
   Census Block Group FIPS Code

These files are constructed from several sources: Census Block Group boundaries and household count from the US Census Bureau, business phone line count per CBG from spreadsheets by John Banks of Sprint, CBG area adjustments from files by Peter Copeland of US West, wire center point and boundary data from OnTarget Mapping's Exchange Info Plus product, and wire center full CLLI codes and operating companies from spreadsheets by John Banks. Each record of the state files contains the following fields, in the order presented here:

- **Switch CLLI**: The 11-character code of the switch in the wire center within whose boundaries the ***geographical centroid*** of the Census Block Group falls. The unique 8-character code provided by the OnTarget data is expanded to 11 by matching it against CLLI codes in the wire center spreadsheet provided to us by John Banks of Sprint; if no match occurs, the last three characters are taken from the first switch listed for the wire center in the OnTarget data.

- **Operating Company Name**: First 20 characters of the name of the operating company of the wire center. This name is taken from the OCNAME column of the wire center spreadsheet provided by John Banks *where a match (as described above) occurs*; where no match occurs, it is taken from the OnTarget data, in which case the styling of the name might be different from the styling of the name in John Banks' data..

- **Operating Company Size Indicator**: The character **L**, **M**, or **S**, indicating the company size. This indicator is taken from John Banks' data, *where a match (as described above)* occurs; where no match occurs, this field is empty.

- **Parent Company Name**: 20-character name of the *parent* company of the operating company. This name is taken from the data provided by John Banks, *where a match (as described above) occurs*; where no match occurs, this field is empty.

- **Cent Off Type**: Single character Central Office Type, also spoken of as "Host/Remote Indicator". This name is taken from the data provided by John Banks.

- **Census Block Group Number**: The FIPS code of the Census Block Group represented in this row. This is in the 12-character form *sscccttttttg*, where *ss*=State, *ccc*=County, *tttttt*=Tract (with no period as punctuation), and *g*=Group (the high-order digit of Census Block numbers belonging to this Group).

- **Quadrant**: Consider angle *Omega* on a sphere to be an angle whose vertex is the location of the Wire Center and whose sides are rays from this vertex; the base side is a ray to due east, the other side a ray through the centroid of the subject Census Block Group. The angle is measured in positive degrees with counterclockwise rotation from the due east point. Then,

  If *Omega* >= 315 or *Omega* < 45, Quadrant = 1
  If *Omega* >= 45 and *Omega* < 135, Quadrant = 2
  If *Omega* >= 135 and *Omega* < 225, Quadrant = 3
  If *Omega* >= 225 and *Omega* < 315, Quadrant = 4

  Quadrant can be calculated by:

  1 + Int(((*Omega* + 45) Mod 360) / 90)

- **Omega**: The angle *Omega* defined above, in degrees with one fractional digit.

- **Alpha**: This angle, in degrees with one fractional digit, is a function of the angle *Omega* and the Quadrant it falls in. Its range is 0 <= *Alpha* < = 45. It can be calculated by:

  Abs(*Omega* - (*Quadrant* - 1) * 90)

  except where *Omega* >= 315, in which case *Alpha* can be calculated by:

  360 - *Omega*

- **Centroid Distance Feet**: The distance, in feet with two fractional digits, from the Wire Center location to the centroid of the subject Census Block Group. This value takes into account the curvature of the earth. In cases where there is more than one switch location within a Wire Center's boundary, the Census Block Group is matched with the *nearest* switch within the boundaries, and this distance – and the angles above – reflect that matching.

- **Total Households**: Count of Households in the Census Block Group. This number is taken from the Census Bureau's 1990 figures, then modified for each Census Block Group of a county by the Census Bureau's 1995 estimate of population change in that county. This number is rounded to a whole number.

- **Total Business Lines**: Count of Business Lines in the Census Block Group. This number is taken directly from the data of the BCM model, in spreadsheets provided by John Banks of Sprint.

- **Area Sq Miles**: Area of the Census Block Group, in square miles with 6 fractional digits. Normally, this is the area of the Census Block Group as determined from boundaries extracted from the US Census Bureau's TIGER files. However, certain low density CBGs are subject to a specific reduction in stated area, based on the road network. For each CBG to which this adjustment should apply, the area is taken instead from a set of files provided by Peter Copeland of US West.

- **Depth To Bedrock (Inches)**: Average minimum depth to bedrock for the Census Block Group, expressed in inches with up to 2 fractional digits.

- **Rock Hardness**: Predominant rock hardness for the Census Block Group ... HARD or SOFT, or blank to indicate neither.

- **Surface Soil Texture**: Predominant surface soil texture in the Census Block Group, an abbreviation of up to 7 characters.

- **Water Table Depth (Feet)**: Average minimum water table depth for the Census Block Group, expressed in feet with up to 2 fractional digits.

- **Minimum Soil Slope**: Average minimum soil slope for the Census Block Group, expressed with 2 fractional digits.

- **Maximum Soil Slope**: Average maximum soil slope for the Census Block Group, expressed with 2 fractional digits

- **New Terrain Variable**: This field is (and will be) empty in the data as delivered ... Note that the last character of each of these records will be a comma, indicating that a field is logically present but actually missing at the end

APPENDIX B

APPENDIX C

BCPM ENHANCEMENTS

- Loop investment costs based on an average nationwide LEC's installed cost. Investment costs of five companies are represented.
- Default costs include current material discounts. Therefore 0% discounts are applied in user input defaults for DLC, copper cable, fiber cable, and switch.
- Labor cost added to cost of material to provide installed cost instead of a factor adjustment.
- Manhole, conduit, poles, anchor and guys, drop terminals and feeder distribution interfaces are specific inputs and not factors.
- Structure tables identify cost of trench by density, percent for different methods of trenching, and separates feeder from distribution for differing construction methods.

Development Of Default Values

To develop a nation wide average of material, placing, engineering, and splicing cost, a data request was sent to participating members of the Best of Breed (BOB) model development team (US West, Bell South, Nynex, GTEC, Bell Atlantic, Ameritech, Sprint, Pacific Bell, South Western Bell, and PTI). The data requested was company forward looking cost for loop material and labor. The material cost provided is based on company specific cost that include price discounts, therefore, no additional discounts are applied to material cost in the user input tables. The cost information was averaged to develop a national average for default values in the BCPM. Due to some material cost being slightly lower in cost than the next size down (this is due to volume pricing), smoothing was perform to price material cost in a linear arrangement. The following are examples of the user input tables and the default values found in the BCPM. In addition, an explanation of the methodology for developing default values and guidelines for user inputs.

Cable Investment:

Copper Feeder Cost Table

FeederCableCost	COPPER FEEDER COST		
FeederCableSize	Cost Underground	Cost Buried	Cost Aerial
4200	$35.60	$33.16	$36.50
3600	$33.30	$30.20	$33.33
3000	$28.21	$29.19	$32.68
2400	$21.50	$26.79	$25.58
2100	$19.49	$22.60	$20.20
1800	$17.38	$20.46	$18.60
1200	$11.95	$13.20	$12.10
900	$9.98	$10.70	$9.18
600	$7.52	$7.27	$6.53
400	$6.55	$5.67	$4.90
300	$4.42	$4.38	$4.20
200	$3.60	$3.49	$3.16
100	$2.65	$2.52	$2.31
50	$1.19	$2.16	$1.91
25	$1.00	$1.93	$1.82

Copper Distribution Cost Table

DistrCableCost	COPPER DISTRIBUTION COST		
DistrCableSize	Cost Underground	Cost Buried	Cost Aerial
3600	$33.30	$30.20	$33.33
3000	$28.21	$29.19	$32.68
2400	$23.02	$25.79	$25.58
2100	$19.50	$22.56	$20.20
1800	$17.55	$20.46	$18.60
1200	$12.07	$13.20	$12.10
900	$9.40	$10.70	$9.18
600	$7.52	$7.27	$6.53
400	$6.55	$5.67	$4.90
300	$4.42	$4.38	$4.20
200	$3.60	$3.49	$3.16
100	$2.65	$2.52	$2.31
50	$2.42	$2.16	$1.91
25	$1.51	$1.93	$1.82
18	$1.32	$1.75	$1.51
12	$1.16	$1.28	$1.20

Fiber Cable Cost Table

FiberCableCost	FIBER CABLE COST		
FiberCableSize	Cost Underground	Cost Buried	Cost Aerial
288	$11.50	$12.79	$12.02
144	$10.30	$9.96	$9.85
96	$7.40	$7.43	$7.19

72	$6.25	$6.00	$6.75
60	$5.50	$5.17	$6.02
48	$4.75	$4.95	$5.27
36	$4.15	$4.01	$4.67
24	$3.75	$3.93	$3.45
18	$3.48	$3.25	$3.26
12	$3.09	$2.75	$3.04

Average installed cost of copper and fiber cables are developed by company forward looking cost using today's discounted material cost. Copper cables are 26 gauge in both feeder and distribution. A 12000 foot total loop length is set as the default for a breakpoint of copper to fiber technology. This means that copper will be the transport medium from the wire center to the subscriber when the total loop length is 12000 feet or less. Loop lengths beyond 12000 feet, fiber will be deployed in the feeder along with digital loop carrier. To extend the breakpoint, a user must assume a 26/24 gauge feeder and adjust cable cost accordingly. In addition, cost of load coils and other transmission requirements must be considered when extending copper loop lengths. Distribution lengths are also set at 12000 feet as a default so as not to exceed DLC powering limitations.

The type of underground copper cable used is DuctPic to avoid pressurization expense. Buried copper cable is filled armored to minimize cable damage due to water, dig-ups, and animals. Aerial cable is single sheath (BKTA/BKMA) when available, otherwise DuctPic cables are used. The default values are an average of the installed costs of the participating LECs data responses. Installed costs include taxes and supply expense, engineering, placing, and splicing. The installed cost of a messenger is included in the cost of aerial cable. For the larger size cables (3000 pair or larger) 16m strand is assumed Buried and aerial fiber cables includes cost for extruded outer duct (cables placed in flexible plastic duct before placement) for additional protection. This method of placing the fiber cable in the duct before placing greatly facilitates the placing operation in aerial and buried plant. Some of the costs are smoothed to provide a linear cost relationship to cable sizes. This is necessary because some cable sizes are purchased on volume and are less costly than cable sizes smaller in size.

Drop Terminal Cost Table

Drop Terminal Cost Installed			
Size	Buried	Aerial	Building/Underground
0	$133.46	$70.44	N/A
6	$157.05	$95.98	N/A
11	$440.87	$131.81	$340.15
26	$451.00	$216.00	$509.43
51	N/A	N/A	$811.60
101	N/A	N/A	$1,293.09
201	N/A	N/A	$1,965.71
301	N/A	N/A	$2,324.03
401	N/A	N/A	$2,839.49
501	N/A	N/A	$3,756.64
601	N/A	N/A	$3,870.42
701	N/A	N/A	$4,385.89
801	N/A	N/A	$4,901.36

Sizes of drop terminals range from 0-25 which equals a 25 pair terminal, to 801-900 which equals a 900 pair terminal. Buried drop terminal costs are the installed cost of buried encapsulated BMT type terminals for size 11 - 50 and 5 pair terminal blocks including pedestals, for 0 - 10. Pedestal cost are included where appropriate therefore no separate pedestal cost is included in inputs. Aerial terminal cost are installed cost for 25 pair strand mounted terminals (105A-25 type) and 50 pair pole mounted terminals (53A3-50 type) for sizes 11-50 and 5 pair terminal blocks installed in ready access closures for sizes 0-10. Additional cost associated with aerial and buried terminals are drop and network interface devises (NID) which are found in other tables Building and underground terminals are protected terminals with connecting blocks mounted on backboards in closets or utility rooms in apartments or businesses. These terminals do not require a NID or drop as inside wiring (IW) is connected directly to the connecting blocks. Both the aerial and buried terminals are linked to single family living units while the building and underground terminals are linked to multi-family and business lines.